EUROPEAN CEMENT INDUSTRY

3/16/99
Copy sent M. P. C. T. 3/16/99 -
M. Ebert
Nov. 30 = 1916.

REPRINTED FROM
THE ENGINEERING RECORD.

THE
EUROPEAN CEMENT INDUSTRY

BY
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NEW YORK
THE ENGINEERING RECORD
1899

PUBLISHER'S NOTE.

Early in the year 1897, "The Engineering Record" began the publication of a series of articles upon the European Portland Cement Industry. The articles were prepared especially for this journal by Mr. Frederick H. Lewis, M. Am. Soc. C. E., who undertook, in the interest of this inquiry, a personal inspection of the important European plants, and who, from his familiarity with the subject, was well qualified to compare foreign with American practice. The plants then described were the works of Hilton, Anderson, Brooks & Co., at Grays, Essex, and the Francis works at Cliffe, the North Works at Beerse, the Alsen, Laegerdorfer & Hemmoor plants near Hamburg, the Hanover Works at Misburg, and Heyn Brothers' plant at Lueneburg, the Dyckerhoff Works at Amoeneburg, Mannheimer Works at Weisenau, and Mannheim & Schifferdecker Works at Heidelberg, German Cement Kilns, the works of Darsy, Lefebvre, Stenne & Lavocat at Neuchatel, and the works of E. Candlot & Cie., at Dennemont.

As the issues containing the articles have now been exhausted and the demand for them still continues, it has been decided to republish them in this form, with some additional illustrations.

EUROPEAN CEMENT INDUSTRY.

The most interesting fact at this time in regard to Portland cement in England is that the manufacturers have awakened to the necessity of improving their products. For twenty years methods of manufacture in England have remained practically unchanged, and the product changed as little as the methods. Portland cement was discovered by an Englishman; it got its name in England and for a quarter of a century its manufacture was wholly an English industry. The traditional policy of the manufacturers toward foreign trade has therefore been simply this: "Here is our cement as it has always been made; you can take it or leave it, for we make nothing else."

With the rise of the German cement industry, many foreign buyers have accepted the alternative, and German cements have displaced the English product in many export markets and quite generally command a premium in price. This appears to have gone on without action in England until about two years ago, when the cement industry reached a crisis of small sales, little or no profit and financial stringency. Since then there have been large consolidations of interests, a better understanding in the trade, and a live interest among progressive men in studying the demands of export markets.

To American minds it must appear most extraordinary that manufacturers in England should have seen trade slipping away for years, and from sheer conservatism have been unwilling to take any steps to stop a loss both of business and of prestige. The real fact is that there have been several factors at work to bring about this state of affairs. The Englishman is conservative, but no one who knows the shrewdness of English business men can believe that they have let business decline from mere

obstinacy. Two other factors which have contributed to the result described above are: 1. the conduct of manufacturing under land leases. 2. the obstinacy, not to say pig-headedness, of the English laboring classes.

The fabric of English law has been accumulating for centuries, much of it yet uncodified, and it is a veritable maze, which Dickens declared to be inexplicable until viewed from one standpoint. When you consider it as a device for making business for lawyers, the whole thing at once becomes perfectly clear. It is a real bar to change to an extent which is hardly realized in America, and in manufacturing as well as in agriculture, it evidently makes the improvement of leased property a matter for serious consideration.

The stubbornness of English labor in adhering to time-honored methods, and the power of the labor unions and of the close trades has often been commented on before. While the labor in England is energetic—" smart"—it evidently has more power and is harder to deal with than in either America or the continent of Europe. In a comparatively close industry like cement making, with the traditions of sixty years behind it, it evidently requires unusual vigor and determination to enforce new methods of work.

At this writing this change of policy, inaugurated two years ago, has resulted in two changes of manufacture. The first is in putting finely ground cement on the market. It used to be considered quite good enough in England to grind cement so there should be a residue not exceeding 10 per cent. on a No. 50 sieve (Am. Soc. C. E. standard). Such cement gave good results in tests of neat briquettes, but when tested as in Germany and America in mixtures of 1 cement to 3 sand, the results were at least 30 per cent. to 40 per cent. below the figures obtained from finely ground cements. The sand-carrying capacity was essential, but was not there.

To show what English manufacturers are now prepared to do, the following figures of a recent lot of cement shipped to America are here given:

99.9 per cent. passes No. 50 sieve.
95.0 " " " " 100 "
78.0 " " " " 200 "

These figures are in excess of any standard for fine grinding

which has come to the writer's attention, and mark a really important improvement in quality.

The second improvement is in making cement with a setting time to suit the conditions under which it is to be used. The old idea that a cement which was good enough for England was good enough for anybody is found to be an assumption which is neither true nor reasonable. It proves to be a fact that a cement which in the moist, cool climate of England will set in, say, 45 minutes, and which can be satisfactorily used there for any purpose, will in the warm, dry atmosphere of an American summer set in from two to five minutes and be quite unfit for laying sidewalks, or for any but rapid work. From a careful comparison of data in England and on the Continent the writer finds that cements leaving Europe with a setting time of from five to eight hours will in America set in less than half these periods. Such changes appear to be quite marked even in winter, when the climatic differences are not great; but they are, of course, much more marked in summer. Even with very great care very queer changes in setting time take place in Portland cements, and the most experienced manufacturers are occasionally nonplussed to account for them. These facts have been receiving great attention from at least two leading English manufacturers in the last two years, and they now declare themselves ready to furnish whatever their customers may desire in this respect.

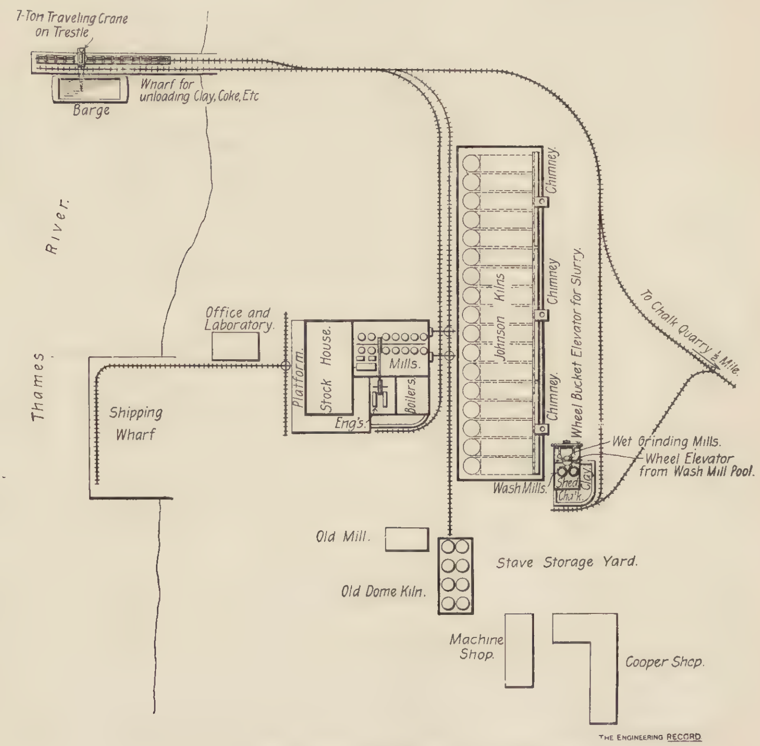
Taken in conjunction with the fine raw material of the Thames and Medway, these two improvements evidently go a long way in improving English cement.

The Works at Grays, Essex.

Through the courtesy of Messrs. Hilton, Anderson, Brooks & Co., the writer had an opportunity to visit in detail their works at Grays, under the guidance of the resident director, Mr. Alfred Brooks. The present firm was formed by a union of the old firms of Hilton, Anderson & Co., and Brooks, Shoobridge & Co. They have four plants, two of them small; the other two, at Grays, on the Thames, and Halling, on the Medway, are quite large plants. The firm produces annually about 800,000 barrels of cement, and has the largest American trade of any English house.

The works at Grays are directly on the Thames, some-

22 miles below London, and are shown in plan in the figure. Vessels of moderate draft can load directly at the wharves. The clay comes from the mouth of the Medway, some miles below, and is very expeditiously unloaded from the barges by means of a clam-shell dredging bucket which is carried by a 7-ton jib crane. The crane runs on a high level track on the wharf and drops its load into cars running at a lower level along-



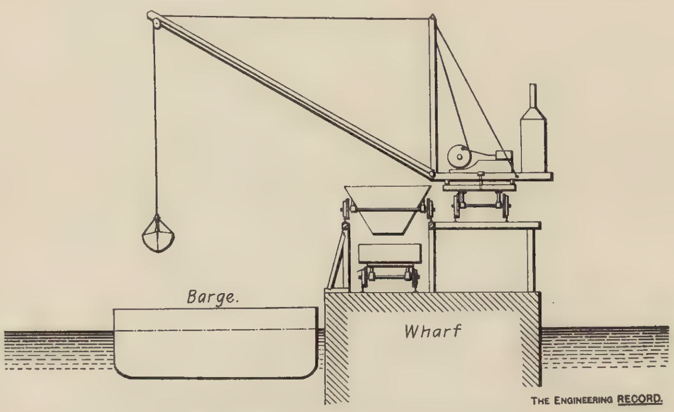
PLAN OF THE CEMENT WORKS, GRAYS, ESSEX.

side the barge. It is by turns yellow or blue in color, but quite pure and free from foreign matter.

The chalk quarry is in the hillside some three-quarters of a mile back from the water front. Here there is a working face of 50 to 75 feet of white chalk, said to be 98 per cent. pure carbonate of lime. It is quite soft, readily breaking in the fingers and readily disintegrating in water in the wash mills. Its only drawback is

the flints, which occur in regular beds, some five or six feet apart, and making clearly defined outcrops across the working face of the quarry.

The process of mixing the raw material is the semi-dry, or Gorham method. In this process the clay and chalk are thrown into the wash mill and mixed in a rather thick slurry containing but 40 per cent. of water. On passing from the wash mill, the slurry is ground wet between buhrstones and then goes directly to the drying chambers of kilns of the Johnson type. The Johnson kiln, it will be remembered, is simply an intermittent kiln having a long drying chamber (or chambers) between the kiln and the chimney. The wet slurry is thus dried by the products of combustion of one charge, and the kiln is then recharged by simply taking up the dried slurry in the chamber and placing it in the



BROOKS-SHOOBRIDGE WHARF CRANE.

kiln. It is evident that a process so simple and so direct could only be carried out with very pure and uniform raw materials. The fuel used is coke from the London gas works.

The balance of the works are much the same as at all other cement manufactories. The crushing and grinding machinery for the clinker, the stock-house and loading and shipping departments, differ only in details at different plants.

Two things of notable excellence about the plant are the power-house and the cooper shop. The engines are compound condensing engines of the Corliss type, with rope transmission directly

from the flywheel. This rope transmission is apparently held in high esteem in Europe, the writer having found it in all the cement plants he has visited. Usually the ropes are hemp and $1\frac{3}{4}$ to 2 inches diameter. At Grays they are of special long fiber cotton. There are about ten or twelve strands leading from the flywheel to the pulley on the main shaft of the mill, and they appear to be in first-class condition after a service of eleven years. They transmit 300 horse-power.

The cooper shop has a full complement of tools for turning out barrels rapidly. One novel feature is the printing of the brand and label directly on the barrel heads. This is done in two overlays on each head and is evidently much better than paper labels pasted on, which may or may not stay—often the latter.

The Francis Works at Cliffe.

The Francis cement is quite an old brand, having been well known in America for twenty years. It has a prominent place in a long series of experiments reported by Mr. W. W. Maclay, M. Am. Soc. C. E., in a paper read before the Society in 1878.

The writer had the pleasure of visiting the works in company with the resident director, Mr. Vitale de Michele, M. Inst. C. E. They are situated on the south side of the Thames, in Kent, some 30 miles from London. They are three plants, one located directly in the chalk quarry, the other directly on the river front, a mile away, and a third between these two points.

The chalk is all quarried in the first plant, while the unloading of the clay (from the Medway) and the shipping is done at the second. The raw materials are precisely the same as at Grays—white chalk, Medway clay and London gas coke. The kilns are of the same general type, and the only difference in process is that at Cliffe the raw materials are mixed with more water in the wash mills instead of by the Gorham process of thick slurry and wet grinding. The power plant here is also excellent. The works in the chalk quarry present a most picturesque appearance, surrounded by the high white walls of chalk. Indeed, the blacksmith shops, stables and other minor offices are in excavations or caves directly in the chalk cliff, presenting a very unique appearance inside and out.

These two works, as described above, fairly represent the English cement industry as it exists to-day. Pure raw materials,

simple direct processes, and the absence of the Continental bureau of "Controle," are its characteristics. The natural advantages possessed by English manufacturers on the Thames are evidently very great, the location and shipping facilities, all things considered, perhaps unsurpassed anywhere in the world. What these plants could do if remodelled on lines of the best modern practice is evidently now the question for English manufacturers to consider. American manufacturers would jump at such a chance without a moment's hesitation.

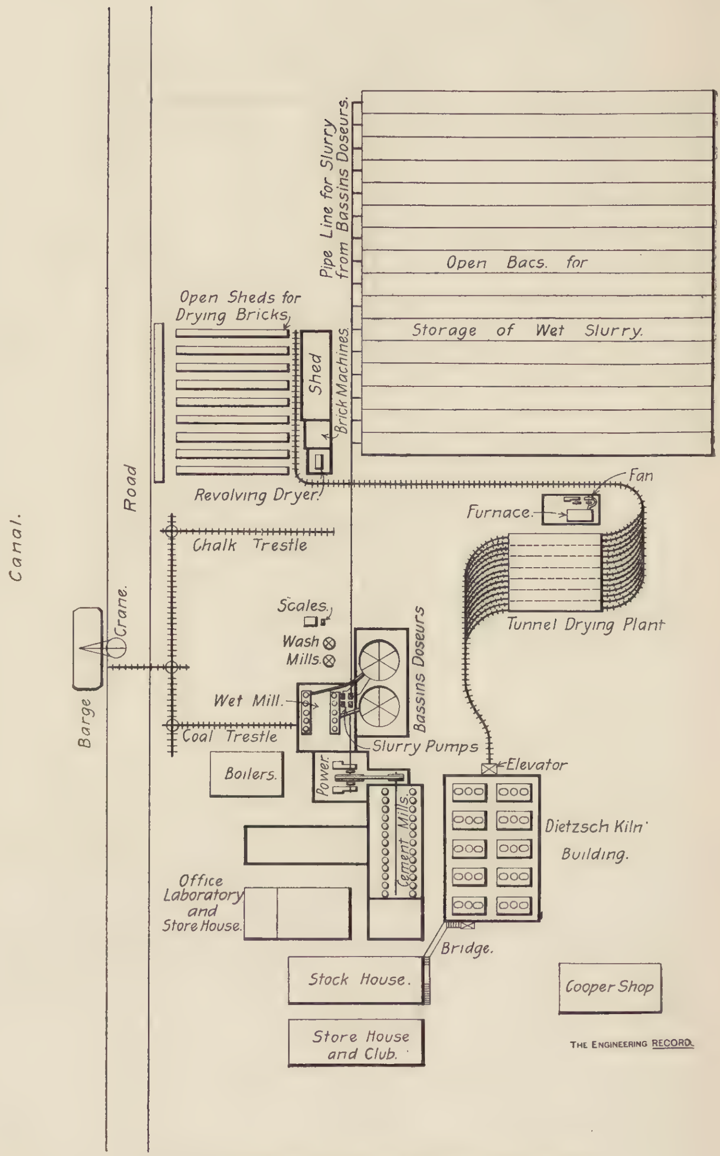
The North Works at Beerse, Belgium.

In Belgium there are two distinct Portland cement industries. These are known respectively as the artificial and the natural Portland cements. Each has a trade association, but the two associations have nothing in common. The artificial Portland cements are made by the standard processes of Germany and France, and there are four manufactories—viz., North's Condor Cement Works, at Beerse; Société Anonyme de Niel-on-Ruppel; Dufossey & Henry, at Cronfestu; Levie Frères at Cronfestu.

The latest of these manufactories is North's Works, at Beerse. The largest is Niel-on-Ruppel. North's Works have been built within the last ten years, the capital being chiefly supplied by the late Colonel North, the "Nitrate King," and the works being built on the plans and under the general supervision of Dr. Wilhelm Michaelis, of Berlin. It is interesting to note, however, that the initiative in building the plant came from an American, Mr. William Schmole, formerly of Philadelphia. Mr. Schmole built the works in association with Col. Alexis Mols, of Antwerp, the present director of the works, and the business was originally conducted under the name of Schmole & Co.

Having abundant capital, the plant was intended to represent the latest European practice, and is therefore very interesting to see. This privilege the writer was fortunate enough to secure through the good offices of the American agent of the firm, and spent Saturday, February 6, 1897, at Beerse, where a party of five gentlemen enjoyed the hospitality of the Director, Col. Mols, and saw the plant under his guidance. The general arrangement of the plant is shown on the following page.

The first thing which strikes the visitor is the fact that the works are built at the clay deposit instead of the chalk, as is usual.



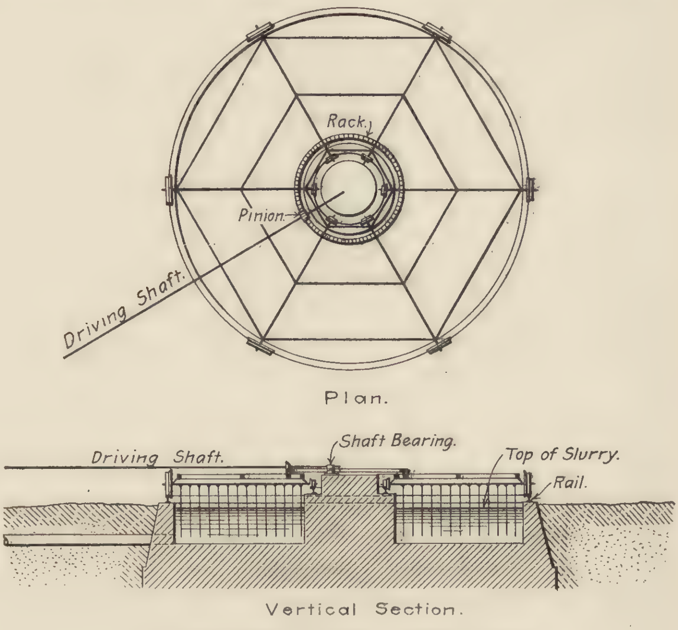
PLAN OF THE NORTH WORKS AT BEERSE, BELGIUM.

The reasons which appear to have dictated this management are, first, proximity to Antwerp, and, second, the establishment of a very large brick-works at Beerse by the cement company, which it operates in conjunction with the cement plant. The first ten or fifteen feet of the clay deposit makes admirable bricks, but is not quite up to the required standard for cement purposes. All the material taken out of the clay bank is thus profitably utilized, and the two industries are conducted side by side by the same staff. This clay is dark blue in color and very plastic, and the chalk which comes from Visé is very similar in color and analysis to the English chalk deposits.

In handling the raw materials the Continental bureau of "Controle" is in entire authority. At the side of the wash mills are the scales and by the scales a telephone to the laboratory. Hour by hour if necessary the proportions of the materials going into the wash mill are modified by telephone orders from the Bureau. The method of working the raw materials is, as indicated above, by the humid way, and this method is here seen in its fullest development. It consists of five distinct processes, as follows: First, the weighing of the raw materials. Second, the mixing of the raw materials in the wash mills, where 60 to 80 per cent. of water is added. Third, from the wash mills the slurry goes to millstones, and is ground wet. Fourth, from the mills the slurry runs by gravity to the bassins de dosage. These are large basins in which the slurry is stirred by arbors similar to those in the wash mills. From these basins samples are taken to the laboratory at regular intervals by orders to the scalesman until the dosage is quite correct. The stream of slurry from the mills is then turned into another bassin de dosage. Fifth, from the bassins de dosage the slurry is pumped through a pipe line to the bassins de repos, or bacs, which cover several acres in extent. Here are stored usually normal cement slurry enough for several months' supply, and here a large part of the water is gotten rid of by evaporation and decantation.

The bassins de dosage were first introduced by French manufacturers at Boulogne, and it is probable they originated with Candlot, the well-known French authority. In his book, Mr. Candlot alludes to these basins as peculiar to the Boulogne plant, where it is well-known he was long the chief of the bureau of "Controle."

In the summer and most of the spring and fall atmospheric influences are sufficient at Beerse to dry the slurry in the bacs for making bricks, and to dry the bricks, when placed in long lines of drying-sheds, for the kilns. In winter, however, this cannot be done, and it will be interesting to the readers of "The Engineering Record" to learn that the latest addition to the works is an American drying plant, the Cummer dryer made in Cleveland, O. This firm makes two forms of dryers, one a revolving dryer for the raw materials, and the other a tunnel dryer for



BASSINS DOSEURS, CONDOR WORKS, BEERSE.

bricks. They have put in both at North's. The revolving dryer is not yet fully installed, but the tunnel dryer is giving excellent results.

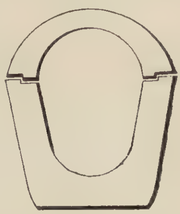
The burning of the clinker is done entirely in Dietzsch kilns, and the grinding is done by millstones. All the mills are ventilated by suction from fans and there is very little dust. Large silos hold the ground cement. There is a cooper shop, a building for storing barrels, and another for storing cement in barrels. Then there is a co-operative store and a club-house for employees. All

the buildings, except the brick works and drying-sheds, are of red brick, giving the plant a substantial appearance.

The product of the works at Beerse is 300,000 to 400,000 barrels, of which 25 per cent. goes to America.

Cement Sewer Pipe and Building Ornaments.

An interesting development of cement work in Belgium is the workshop of Blaton-Aubert in Brussels. This firm does contracting for public works and manufactures cement sewer pipe, both round and egg-shaped sections. The latter are made in two parts, a bottom and a cover as shown in the accompanying cut. The feature of their business which is especially interesting, however, is the manufacture of moulded work in Portland cement mortar. They make vases, busts, statues and large groups in this way, of many designs and of handsome workmanship. In fact they reproduce in cement all the work of this



kind which is seen in plaster of paris or terra-cotta, with the great advantage that the product will stand exposure to the weather indefinitely, improving rather than deteriorating with age. The moulds used are of plaster of paris, each large section made of hundreds of small sections dove-tailed together so they can readily be taken apart one piece at a time. The product seems to be much appreciated and in demand for galleries, gardens and parks.

The Hamburg Cement District, Germany.

The first plant for manufacturing Portland cement was built on the Thames in England in 1825 by Apsdin, one year after the new product had been patented. But it was not until 1852 that the first German manufactory was begun. This was the Zulchow works at Stettin, built by Bleibtreu. To-day there are more than 100 manufactories of Portland cement in Germany, with an annual output considerably exceeding that of any other country, and with a high reputation for the general excellence of the product.

For purposes of comparison of English and German methods of manufacture the works in the vicinity of Hamburg are especially interesting, because the raw materials are quite the same there as in England. That is we have in both places the soft

chalk of the North Sea coasts, readily disintegrating in water, and soft plastic clay of quite similar composition. Of these German plants the writer had the pleasure of visiting three, the Alsen and the Laegerdorfer plants on the north side of the Elbe River at Laegerdorf and the Hemmoor plant on the south side of the Elbe at Hemmoor.

The Alsen Plant.

By common consent the largest plant in Germany is the Alsen Works, near Hamburg, with an annual output variously estimated at from 700,000 to 1,000,000 barrels, quite a considerable percentage going regularly to the American market. The works were built by Alsen & Son, and the business is said to be still a close corporation owned by the Alsens. Mr. Carl Krichauf is the managing director, and it was through his courtesy that the writer enjoyed an opportunity of seeing their plants. They have three works, which are operated practically as one. The plant at Itzehoe is situated at the clay deposit, while the two plants at Laegerdorf are built alongside the chalk quarries. Itzehoe is to the north of the Elbe River and about 45 miles from Hamburg, on the West Coast Railroad to Northern Germany and Denmark. Laegerdorf is four miles from Itzehoe, on a canal leading to the railway and the river. The Alsens, however, operate a narrow gauge railway between the two points, carrying chalk and clinker to the Itzehoe plant and clay and coal to the Laegerdorfer plants. As all the clinker is ground and barreled at Itzehoe, and there are two works at the chalk and one at the clay, the traffic on the railroad is about equal in amount in each direction and the plant evidently designed for economical operation. There is a fine highway between the two towns, level for the most part, but skirting the wooded hillside of a large estate. Hills are very rare in Northern Germany, where most of the country is as flat as a Dakota prairie, and this road along the hillside is unusually attractive.

The raw materials of the Alsen properties are both apparently of excellent quality, the chalk in particular being of a fine white color in all parts of the two large quarries. Mr. Wolf, the chief of Bureau of Controle, is indeed quite enthusiastic over the quality of his raw materials and of the slurry he gets from them.

The mixture is by the humid way—the wash mill and the settling basin. The opinion seems to be universal in North Ger-

many that the wet process is the only one to be considered for chalk and clay. Indeed, some manufacturers claim that better results can always be obtained by the wet process, whatever the raw materials. This view does not, however, prevail in South Germany, where the dry process is quite generally preferred. Certainly, however, remarkable results are obtained by the wet process considering the simplicity of the means employed. Practically the mixture is final at the wash mill. That is, there is no mixing done in the settling basins and there is no agitation of the material in them except by the stream of slurry pouring in. Yet the limit of variation allowed in regular calcimeter tests by the Bureau of Controle is declared to be 0.5 per cent. With materials which disintegrate in water as readily as chalk and clay, the settling basin seems to be all that is required to secure homogeneous slurry.

The Alsens ball the slurry (instead of making bricks of it), dry it in tunnel dryers and burn it in continuous kilns. Some of these are continuous kilns of the well-known Dietzsch pattern (or "two-storied kiln"), but most of them are of the German style of high kiln or schachtofen, originally intermittent kilns, but remodeled so as to work continuously. This they are said to do very satisfactorily, both in respect to output and economy of fuel. The Bureau of Controle has a well-equipped laboratory and there are smaller laboratories for physical tests at each plant.

At the Alsen quarries all the material is handled by railway, and this service in connection with the line between Itzehoe and Laegerdorf, demands quite a considerable equipment in motive power and rolling stock and in facilities for repair, etc.

The firm owns, too, a large track of land not required for manufacturing, and this is devoted to farming and stock raising. One of the principal buildings of the village street is the Alsen cow barn for housing the milch cows and their calves in winter. Built of brick and iron throughout and fitted with many ingenious contrivances, it affords stable room for some 60 head of cows, beside separate quarters for 20 or 30 calves, rooms for milk storage, creamery, etc. The firm has beside in the village a workingmen's boarding-house and a workingmen's club-house, both of ample size and well equipped and maintained, and it would appear that the laboring class might find many worse places to live in than Laegerdorf.

The Laegerdorfer Plant.

This is a comparatively new plant, with an annual output at present of 200,000 barrels. It is on the canal, one-half mile above the village. The raw materials are like those at the Alsens', the chalk being in fact quite the same; the mixture is also the same, except that there are small settling bacs provided between the wash mill and the bassins de repos, evidently for the purpose of eliminating any sand which may be present.

The settling basins cover quite a large area on each side of the canal. These great areas of bassins de repos are indeed a feature of the Hamburg plants. The slurry dries so slowly in them in winter that it is necessary to provide large storage capacity. The works have a complete brick plant with a system of tunnel dryers. The kilns are six in number, double Dietzsch continuous kilns, and the grinding is by French buhrstones. The stock house is across the canal from the mills, and a novel feature is a belt conveyor taking the ground cement across a bridge turning at right angles, and delivering it in the stock house some 200 feet away. Another phase of American enterprise is met at the Laegerdorfer works, this time in the form of a set of American drying kilns for drying barrel staves.

The Hemmoor Plant.

This plant is quite large, producing 500,000 to 600,000 barrels per year, and has evidently been in operation a number of years. It is situated 50 miles from Hamburg, on the railroad to Cuxhaven. The method of manufacture is practically identical with that of the Alsen works, and the kilns are alike in the two plants—Dietzsch kilns and high kilns remodeled to work continuously. There are two features worth special notice—one, the use of the American Griffin mill for grinding, and the other the fine laboratories of the works, both for research and for Controle. The director of the works is Dr. Pruessing, whose name became familiar to American readers in connection with a report made a year or two ago on accelerated tests of cement, and the doctor has notably good laboratories, well equipped for every kind of test that has ever been proposed for cement.

A new form of accelerated test is here used, designed by Dr. Pruessing and which is as follows: To 100 grams of neat cement, 7 grams of water are added and well mixed; the very dry mortar

thus made is then placed in a matrix 8 centimeters in diameter and subjected to a pressure of 2,500 kilograms. The cake is at once removed, and after hardening for 24 hours in air is subjected to the hot bath at a temperature of 70 degrees to 80 degrees Centigrade. It is claimed that this test is more severe than any form of boiling test yet devised, and as such it may commend itself in America to those who are looking for a test of this description. It is only fair, however, to add that the apparatus is rather expensive.

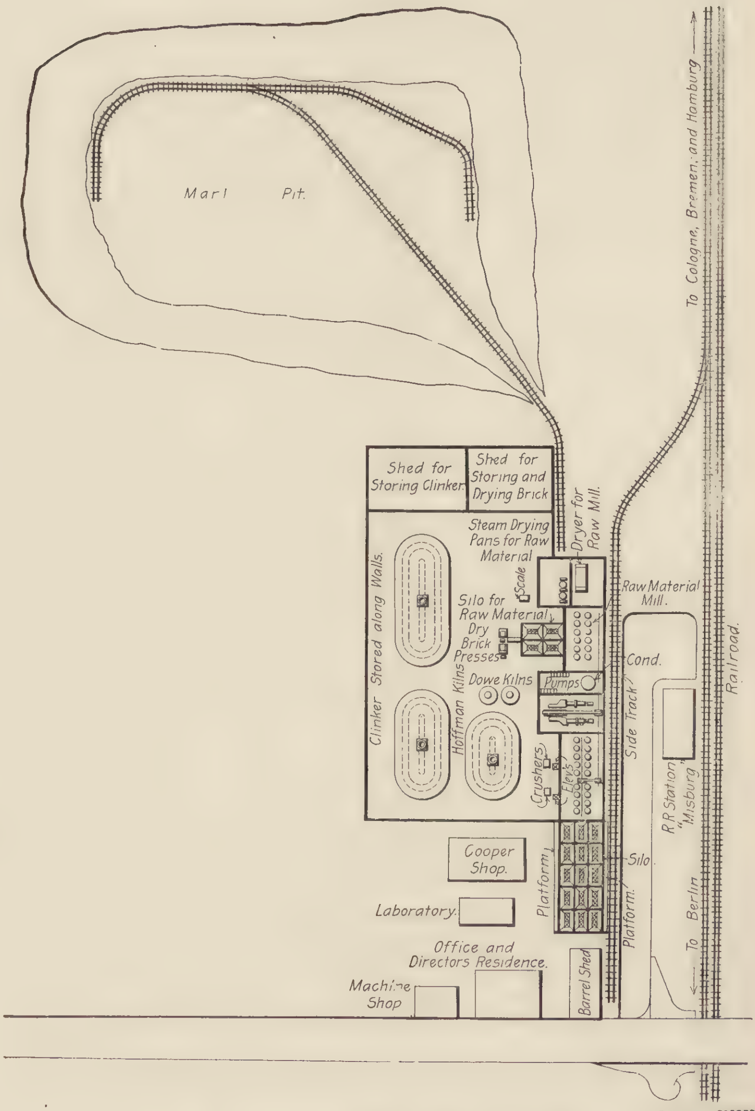
From these brief descriptions of the Hamburg plants, it will become clear to the readers of "The Engineering Record" that the German practice of dealing with chalk and clay differs from the English in two points, viz.: 1. The use of bassins de repos. 2. The operations of the Bureau of Controle. Any other differences are merely those of detail.

The German Marl Cements; The Hanover Works at Misburg.

There are an interesting group of German Portland cement works employing "mergel" (English, marl; French, marne) as the principal raw material. "Mergel" is a natural mixture of clay and carbonate of lime and is generally fossiliferous, containing shells and frequently other fossils. The writer enjoyed an opportunity of visiting two of these works—the Hanover plant at Misburg, and Heyn Brothers plant at Lueneburg. In the former the method of procedure is by the dry way, and as this method has not yet appeared in this correspondence, the Hanover works will be described first.

The Hanover Portland Cement Works are located at Misburg, a few miles east of the city of Hanover, on the main line of railroad between Cologne on the Rhine and the capital at Berlin. They have also direct rail communication northward with the ports of Bremen and Hamburg. The works are under the joint resident direction of Dr. Erdmenger and Mr. Kuhlemann, both well-known and prominent men in the German Association. They are shown in plan on the following page.

The natural advantages of the plant are at once apparent. It is built directly at the railroad, with siding facilities like any other manufactory, while just below the surface of the ground is found a marl deposit some 40 odd feet in depth over the entire



PLAN OF THE HANOVER WORKS AT MISBURG.

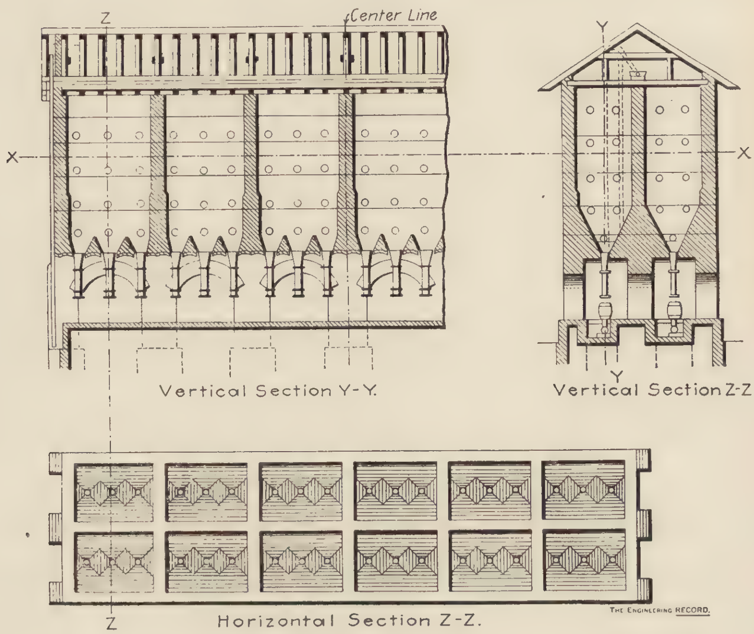
property. Immediately below the marl is found the clay. Both raw materials thus occur directly in situ and are cheaply and expeditiously handled by an inclined plane descending from the rear of the mill.

The marl is grayish white in color, as soft and apparently as easy to dilute with water as chalk. It is a natural mixture of carbonate of lime with clay, quite free from other impurities. The proportion of clay in the marl varies from place to place over the face of the quarry, but is generally within 10 per cent. of normal proportions for cement. At the time the writer was there, the marl was exactly normal, being used just as it came from the quarry. The clay is really another bed of marl in which the clay predominates instead of the carbonate of lime.

Under these conditions the ordinary work of the Bureau of Controle is very simple. Nature has already mixed each of the raw materials with a large proportion of the other; to strike a close average of normal proportions and to further complete the mixture is evidently a matter of simple routine. In the operations of the Bureau of Controle the raw materials are analyzed regularly as they come from the working face of the quarry, and the mixing proportions are slated at the scales from day to day or even from hour to hour if necessary. A second determination is made after the material has been ground dry and has passed into the silos, and lastly a third determination is made of the bricks prepared for burning. These analyses proceed in regular course under a system of routine adopted by Dr. Erdmenger, which has proved so efficient that the doctor declares the analyses of bricks are "always right" within a limit of one-half of one per cent.

As the raw materials come from the quarry they contain something like 11 per cent. of water, which must be eliminated before the material can be ground. It was formerly the custom to bring the raw material from the quarry and spread it on steam drying pans placed upon the ground. To dry the material in this way, however, required a large area covered with drying pans and a great deal of manual labor in loading and unloading. Besides, it evidently was not economical in fuel. The company had therefore modified the plant just prior to the writer's visit by the installation of a Cummer revolving dryer for drying the raw materials. This is the American dryer mentioned previously in these

descriptions, and as installed at the Hanover works is giving very satisfactory results. The method of working with the new dryer is to bring the raw materials directly from the quarry to the scales and thence to an edge-runner mill. This edge-runner mill consists simply of a pair of large rolls fitted loosely on the same axle and running on a revolving plate below. The outer third of this revolving plate is perforated with holes, so that all material up to the size of a pea shall pass through. From the edge-runner mill the material is carried by elevator directly to the Cummer dryer,



GERMAN CEMENT SILO.

through which it passes continuously at the rate of 15 tons an hour. Thence it is carried by elevator and transmission apparatus to the mill, where it is ground, bolted and passes to the silos for raw material. With such soft raw materials and materials which are already approximately normal in their natural state, it is evident that the edge runner and the mill stones will complete a very intimate mixture. A curious evidence, however, of the purpose to insure a homogeneous mixture by every means available is seen

in the long lines of worms which conduct the pulverized material from the mill to the silos. These worms, instead of being continuous, are made of a series of knives bolted at intervals to a central shaft. When Dr. Erdmenger was asked why this discontinuous worm was used, he said it was for mixing; at every blade a part of the cement was pushed on and a part remained, and thus the mixing went on continuously with the transfer of the material. This same style of worm is used in forwarding the material to the brick machine and also in forwarding the cement to the cement silos.

A German cement silo is, as near as may be, built on the model of an American grain elevator. That is, it consists of a series of bins, in which the dry material is deposited by elevators and from which it is drawn below by spouts. An illustration of the type of construction used is given in the cut. The kilns at the Hanover plant are Hoffman kilns or so called "ring ovens," which require the raw materials to be delivered in the shape of bricks. But as the method of working is entirely by the dry way, and as any moisture used to mold the bricks must be subsequently driven out either by exposure to the air or by the heat of the furnace, it is desirable to make the bricks with as little water as possible. This is done by running the ground raw material continuously through a sheet metal trough and adding a small continuous stream of water intended to be from 5 per cent. to 7 per cent. Thence the material is passed to the brick machine. This machine is not a pug mill, such as is used in making bricks in wet processes, but a press known to the trade as a dry press. In this press the raw material falls through hoppers and is automatically delivered to the molds. The heavy presses are raised by cams and strike each brick three sharp blows, delivering it warm, firm and nearly dry. The bricks are stacked in great piles in sheds, so that they lose most of the water they contain before being placed in the kilns.

The Hoffman kiln or "ring oven" in use in the Hanover works was originally used in Germany in making bricks. It consists of a continuous gallery of an elliptical shape built around a central chimney. There are usually 15 or 20 compartments, with as many entrances from the outside and as many ports leading to the chimney. In practical working in a kiln of 20 compartments, there are, say, six which are filled with burnt clinker, still warm,

two which are in process of burning, six which are filled with bricks not yet burned, and in the remainder charging and discharging is in progress. The connection with the chimney is by the port in the last chamber filled with bricks, and the draft is through the open door of the compartment on the other side which is being discharged of clinker. All intermediate openings, both to the chimney and to the outside, are sealed and a heavy paper partition is pasted across the gallery (and against the bricks) just beyond the open chimney port. Thus the air is heated by passing through the hot clinker in six chambers and arrives at a high temperature in the combustion chamber. Similarly the products of combustion pass through several chambers filled with bricks which are thus heated to a high temperature before burning actually begins. These kilns are widely used in Germany and evidently are economical of fuel, but expensive in manual labor. In the best practice with Hoffman kilns about one ton of coal is required to produce 6½ tons of clinker, a performance which is very much better than anything which has ever been done with discontinuous kilns. At the Hanover works they have three of these kilns, with a capacity of 70,000, 80,000 and 100,000 barrels per annum respectively, and they also have three of the old discontinuous dome kilns, so that their annual capacity is about 300,000 barrels. The grinding of the clinker is done entirely by French mill-stones and the fineness regulated by bolting through sieves. The cement is stored in silos.

The power plant of the works, like nearly all European power plants, is of a high standard of excellence. For grinding the raw material there is a compound Corliss engine of 250 horse-power and for grinding the clinker a similar engine of 900 horse-power, and in both engines the power is taken directly from the flywheel by rope transmission. The works have a fair laboratory service for control, and a laboratory for research which is only remarkable for the high character of the work which Dr. Erdmenger turns out of it.

Heyn Brothers' Plant at Lueneburg.

This plant is situated in the ancient town of Lueneburg, about an hour's ride by express train to the south from Hamburg, and having both rail and canal facilities. The marl is practically the same as at Hanover. The clay is more nearly a pure clay. The

method of work, however, is entirely by the wet process, employing the wash mill, settling basin and brick making with tunnel dryers for drying the bricks. The plant is in excellent order, showing many details of mechanical excellence. The marl quarry is perhaps a quarter of a mile from the wash mill, on the other side of the highway, and the raw materials are carried by wire cableway across this space with rapidity and economy. Similarly in the brick-making and brick-drying plant, the carriages are run on a system of overhead runways exactly similar to those in use in a Chicago packing-house. All the buckets, however, are provided with grips, and in leaving the brick-works for the top of the Dietzsch kilns they are gripped to a cable and carried forward and upward by it. On the upper stories of the kilns the buckets are again carried by a system of runways. The whole scheme is expeditious and economical. The firm employs Dietzsch kilns exclusively to burn their clinker, and are preparing to use the American Griffin mills exclusively for grinding. They have had two of these mills in use for some time, but are now putting in three more which will grind the entire output of the works. It is evident that the advantages of the Griffin mills must have proved considerable at Lueneburg, since they will displace a very excellent plant of French millstones. Except therefore for the raw material employed, which is chiefly marl instead of chalk, the Lueneburg plant might be classified with the Hamburg plants.

There are a number of other works in Central Germany employing "mergel" as the raw material, the largest of them being the Germania Works at Misburg and Lehrte.

German Cements from Hard Raw Materials—The Dyckerhoff Works.

No brand of imported cement is better known in America than the Dyckerhoff cement, and no manufacturer has maintained a more constant interest in the technical side of cement making or taken a more prominent part in such questions before the German Association than Mr. Rudolph Dyckerhoff. The Dyckerhoff plant is located directly upon the River Rhine, at Amoeneburg, a few miles below the city of Maintz. The river is an important factor in the plant. The coal comes by barges, the clay also is brought from the Main, the tributary stream a few miles away, and the greater part of the product of the works is shipped

by the river. From the river side there is a cable tramway leading under the highway through the works. The plant itself covers a large area, and the process of dealing with the raw materials is quite unique. Back a mile or two from the river front is the limestone quarry, and this quarry contains in different beds three different grades of stone. These are: 1, a hard limestone; 2, a soft limestone, and 3, a soft marl. By the process employed all three are utilized, and as will be seen below they are not only utilized, but this diversity in the character of the rock becomes a positive advantage. The hard and soft limestones are substantially the same in composition, and do not vary much, being approximately 80 per cent. carbonate of lime The marl is more irregular in composition.

Thus, with the clay, the plant employs four different raw materials. In order to do this two distinct plants are employed, one dealing with raw material entirely by the dry way, and the other dealing with it entirely by the humid way. The raw material prepared dry is the hard limestone, with such suitable additions of soft marl and clay as may be required to produce normal composition for cement. These three materials are first dried over drying furnaces, then pass through crushing machinery and are ground and incorporated together in millstones. While this process is going on at one plant, a wholly different preparation by the humid way takes place at the other. In this the soft limestone, marl and clay are brought together, in proportions fixed by the Bureau of Controle, in wash mills. Thence the stream of slurry passes to millstones and is ground wet, and from these mills it is pumped to long lines of troughs mounted on trestles to the settling basins, where it dries by evaporation and decantation, as in the regular wet or humid process. It is probable that the soft limestone and marl of the Dyckerhoff works is less easily diluted with water than the materials found further north in Germany and that this makes the wet grinding desirable. The wash mills, too, instead of being provided with harrows on arbors, as in the mills in Northern Germany, are provided with edge-runner stones which crush as well as mix the raw materials.

The two processes, wet and dry, go on side by side at the rear of the works, the part most remote from the river. Lying immediately in front is a large area devoted to bassins de repos and traversing this are the overhead runways for conveying the slurry

to the basins, an overhead cableway for conveying the dry raw material to the brick plant, and tramways on the ground for conveying the thick slurry from the bassins de repos to the same point. At the brick plant the wet and dry materials are brought together, and the first operation is to mix the wet slurry with the dry powder in any required proportion to give the material the proper consistency for the brick machines. As both wet and dry materials are normal in composition (or intended to be so) the proportions in which they are mixed is immaterial, and may be varied at will by the foreman, whose only care is to produce the consistency required. It is here that the utilization of the hard limestone by the dry process becomes a distinct advantage in working. The slurry can be used much wetter than if only wet material was used. This is an advantage at all times, but especially so in winter, when the drying of the slurry is always slow, and often a serious difficulty. The two materials are mixed in malaxeurs, and from them are carried upward by an inclined belt conveyor to the top of the brick-making machines. The whole process is well considered and carefully worked out to suit the conditions.

At the Dyckerhoff plant, Hoffman kilns are employed exclusively. The works have seven of these kilns, producing yearly about 700,000 barrels of cement. The standard kiln of the works has 20 compartments, and a round of the compartments is made twice a month. Each compartment is reckoned to produce from 250 to 300 barrels of cement. All the kilns are arranged with drying chambers, in which the bricks are dried by the waste heat. These chambers are built around the upper or firing deck of the kilns, and have large ventilating hoods in the roofs above. A good many bricks are also dried directly on top of the kiln. There are two special grinding plants for clinker, both using French millstones exclusively and both having fine power plants. One mill has a compound Corliss engine, and the other a new 1,000 horse-power triple-expansion engine, probably the handsomest piece of machinery in any cement works in Europe.

Dr. Schumann is at the head of the Bureau of Controle of the Dyckerhoff works, and has an excellent laboratory, which does not only this work, but a large amount of the experimental work in which Mr. Dyckerhoff and Dr. Schumann are engaged. For more

exact analyses the firm avails itself of the laboratory of Dr. Fresenius of Wiesbaden.

The Mannheimer Plants at Weisenau and Mannheim.

The Mannheimer Portland Cement Company is one of the oldest in Germany, two others only, it is believed, antedating it, and a considerable part of its product has for many years found a market in America, where it has held an excellent reputation. The original works were located at Mannheim, but a newer and larger plant has now been built at Weisenau, just outside the city of Maintz. The Weisenau plant is thus evidently the more interesting of the two, but as the writer did not know this he went to Mannheim and did not see the Weisenau plant. As described by Mr. Merz, the director of the company, the raw materials at Weisenau are substantially the same in character and from the same geological formation as the Dyckerhoff works. The plant is on the opposite side of the Rhine from Dyckerhoff's and but a few miles distant. In working the raw materials also the process follows similar ideas, but differs considerably in details. At Weisenau, the hard and soft limestone and the marl are all prepared by the dry way. The clay only is made into slurry, and the dry pulverized limestones and the clay slurry are incorporated by special machinery adapted for this purpose and the paste made into bricks. This is evidently another adaptation of means to ends in dealing with these raw materials and is an ingenious modification of the dry process. The plant at Weisenau uses both Dietzsch and Hoffman kilns, and produces 350,000 pounds of cement annually.

At the Mannheimer plant we find raw materials which are harder than any yet described. The limestone, which is 85 per cent. of the material employed, is all quite hard, and the clay is shaly or partially indurated. The method is wholly by the dry process. The material is all dried on open dryers set on the surface of the ground and the materials are mixed, crushed and ground dry in millstones. The pulverized raw material is then made into bricks with a limited quantity of water, and the bricks are then dried for the kilns. It will thus be seen that the handling of the raw materials at Mannheim is not essentially different from the method pursued in the Lehigh Valley of Pennsylvania.

The Mannheimer has five Dietzsch kilns and one Hoffman kiln,

and produces about 250,000 barrels of cement annually. A part of the grinding is done by millstones, but a more recent installation is the German "kugel" mill, a revolving cylinder with fluted sides, in which the clinker is ground by the impact of the steel balls. The product of this mill is bolted and the coarser particles are then re-ground in the new Danish ball mill. This is specially adapted to fine grinding and is simply a revolving cylinder loaded with flint balls which grind by abrasion and impact.

The Schifferdecker Works at Heidelberg.

The Schifferdecker works at Heidelberg were destroyed by fire some time ago, and are now in course of rebuilding. The writer had a cordial invitation from Mr. Schott, the director of the works, to visit the plant, but was unable to do so on account of other engagements. The plant is said to employ hard raw materials exclusively, and a conception of the size of the new works may be arrived at from the fact that the firm has ordered 65 Griffin mills for grinding the raw material and clinker. The interest in these works would be chiefly in the details, since the general method of handling material by the dry way has already been described in this correspondence.

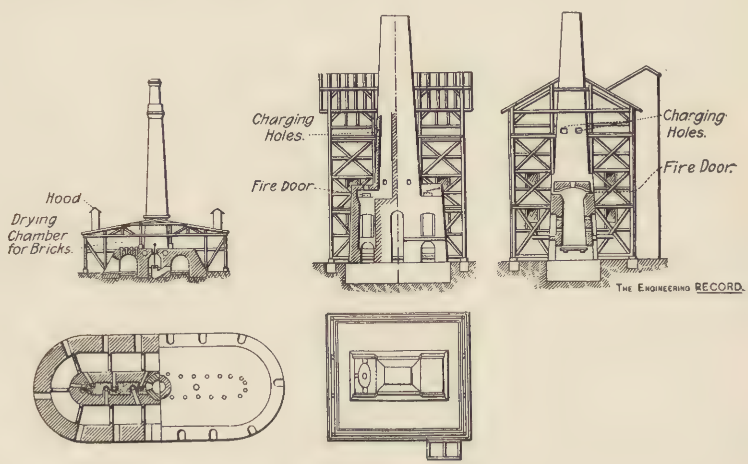
The readers of "The Engineering Record" will already have discovered from these letters that there is no "German" method of making cement. The successful plants are those which most intelligently adapt means to ends and suit their plants to the raw materials and to the local conditions. This is a very old idea, often lost sight of, but is evidently the only basis on which successful manufacturing can be conducted either in Germany or in America.

The German Cement Kilns.

The kilns now most generally approved and most widely used in Germany, for the manufacture of Portland cement, are the Dietzsch and Hoffman kilns, both of which have been mentioned in this correspondence. They are both continuous kilns, but differ in this respect, that while in the Hoffman kiln the fire passes from chamber to chamber and the material rests in place, in the Dietzsch kiln the combustion chamber is fixed and the material passes through the fire. The kilns are both also economical in fuel and both accomplish this in substantially the same way, that is, they heat the draught of air by passing it through

the burnt clinker before it reaches the combustion chamber, and they utilize the products of combustion to heat the raw material before it is subjected to the fire. In the Dietzsch kiln the furnace is vertical and in the Hoffman it is horizontal.

The general scheme of the Hoffman kiln was described in the letter on the Hanover Works, but this will be made clearer by the figure, which is taken from the recently published book of Dr. Schoch, of Berlin. The bricks are wheeled into the chambers at the ground level and piled by skilled workmen. The fuel is introduced from the top through the orifices in the roof. It is necessary to pile the bricks in quite a special manner, so that the gases may pass readily through the mass and to leave vertical



GERMAN CEMENT KILNS.

spaces beneath the opening in the roof through which the fuel may descend to the bottom. The practice in this respect differs in different works as the result of experience, but the scheme will be readily understood from the illustration and description given.

The Dietzsch kiln is shown in detail at the right of the cut, taken from a bulletin of the French "Société d'Encouragement pour l'Industrie Nationale." The drawing is practically a working drawing of the Dietzsch kiln, or the "kiln with stories," as it is also called. This kiln was patented in 1884 and first used in 1886, since which time a large number of them have been built in Germany. The kiln is operated continuously by charging the dried

slurry into the chimney through the door shown at the upper floor of the kiln building and by drawing the burnt clinker from the grate at the bottom. The peculiarity of the kiln is at the fire bridge, where there is a horizontal offset uniting the lower and upper parts of the stack. The part of the furnace just below the fire bridge, some 5 or 6 feet in depth, is the combustion chamber. The chimney above is the pre-heater for the raw material and in the shaft below the combustion chamber the clinker is cooled.

In practical working the dried bricks or dried slurry are carried by elevator to the fifth story of the kiln building and are charged into the chimney. The chimney is kept filled with bricks to or near the level of the charging door, and at the bottom they fall across the fire bridge half way to the combustion chamber. At certain intervals throughout the day the burnt clinker is drawn from the bottom of the kiln and the entire mass above the fire bridge descends. This is then filled by drawing bricks from the chimney across the fire bridge to the combustion chamber and adding with them a proper quantity of fuel. The most trying labor at the kiln therefore is at the level of the fire bridge, which is the third story of the kiln building. Here the bricks must be carried across the fire bridge by manual labor employing long handled iron bars through the fire doors, and the fire must be regularly maintained.

The fuel used is a powdered gas coal containing a large percentage of volatile matter, so that the flame from it passes over the fire bridge and up the chimney. The bricks in the chimney are thus gradually heated as they descend, until at the time they reach the fire bridge they are red hot and practically all the carbonic acid has been expelled. In the combustion chamber the bricks are clinkered, and in the shaft below the burnt clinker is cooled by the draught of air so that it reaches the grate at the bottom cold enough to handle. In the latest practice the Dietzsch kilns are operated under forced draught.

Just below the combustion chamber several doors are provided in the side of the kilns to observe the fire, so as to know whether it is proceeding properly. From these doors and also from one in the top of the kiln, just over the combustion chamber, the fire can also be poked to prevent balling up of the clinker, or to detach masses clinging to the sides.

In the actual working of the kiln proper the Dietzsch kiln

is more economical of fuel than the Hoffman, but since it is necessary to use thoroughly dried bricks in the Dietzsch kiln, requiring generally some artificial heat for drying, the total fuel consumption is probably not very different in the two kilns, showing a production in first class practice of between six and seven tons of clinker per ton of fuel. In manual labor also there is probably not a very great difference in the working of the two, drying and calcining both considered, the advantage if anything being probably in favor of the Dietzsch kiln.

In fact the impression of the writer is that both in fuel and labor there is some advantage in favor of the Dietzsch kiln, while for yield on capital invested in the plant, the Hoffman kiln makes the better showing.

Portland Cement in France.

French Portland cements are not exported to America, and the character of the French works and their products are very little known with us. Yet in several important respects French practice in making and in using cement is extremely interesting. Nowhere is the industry better organized, or does its organization more strictly follow the lines of scientific method, and nowhere does practice represent greater experience. This may surprise those who know the comparatively small output of cement in France; not more, perhaps, than one-fifth of the German product. But it is so, and an explanation is found in well-known facts, the force of which will be recognized once they are cited.

One of these is the early precedence which French science took and has since held, in dealing with the phenomena of hydraulic binding media. A dozen years before the Portland cement process was discovered, Collet-Descotils, of the "Ecôle des Mines," at Paris, demonstrated that the silica in lime rocks became soluble when the limestone was brought to red heat, and he argued from this that the silica combined with the lime during calcination to give it hydraulic properties. This is the fundamental fact of all cement making. Vicat's long series of investigations dates from the same early period, and his books are classics of cement literature. Many names will be recalled since these, and among them the present group of men who are to-day treating this subject with such marked ability in France.

The second reason which gives the French industry and French

practice special interest is the fact that the manufacture of cement in France is virtually controlled by the engineers of the Ponts et Chaussées, the celebrated corps which, for 175 years, has been charged with the public works of France. Just what this means will be better appreciated by a comparison. Thus, with us the national public works do not carry much prestige, are, in fact, of quite minor importance, often less in annual expenditure than the public works of some of the greater cities. Yet it will be readily admitted that if a standard specification for cement were adopted by the U. S. Engineer Corps, it would have great weight with manufacturers and with consumers. Now, in France the administration of national public works is charged with the supervision of "all works of a public character or necessity, whether undertaken by the State, the department, committees, public boards or syndical associations," and whether paid for at the government's expense or not. These works comprise "the construction and maintenance of the public roads and bridges, the construction and maintenance of commercial ports, dykes, sea-coast works—such as dredging, etc.—canals and works for maritime purposes and navigation of the interior, the establishing and building of lighthouses, beacons and buoys, the improvement and maintenance of the navigation of rivers and tributaries, towpaths, jetties, piers, works for shore protection to river banks—drainage and reclamation of lands, construction and maintenance of railroads, etc." Military works, city works proper and private enterprises without public interest are excepted, but practically all the rest comes under the supervision of the Engineers of the Ponts et Chaussées. The specifications of this great department of public works become, therefore, of prime importance to manufacturers, and of the greatest interest to anyone who would make himself familiar with French cement affairs. The scope which these specifications have will be apparent from the following extract from Article 2 of the specifications of the Maritime Service: "The Administration reserves to itself the exercise of control, under conditions which shall be determined by it, of the fabrication, the preservation in store at the works and the shipping of cement which may be furnished in executing the present contract. For this purpose the engineer or his delegate shall have access at all times in the parts of the works engaged on this product, and he shall be able, 1. to make all dis-

positions that he shall judge necessary to assure himself of the composition of the crude slurry employed for the product intended for the Administration; 2. to control the sorting of clinker for calcination; 3. to follow the cement submitted from the sorting of the clinker to the special warehouse where it will be stored for shipping; 4. to control the special lead sealing of sacks leaving the storehouse and the shipping of the cement; 5. to place special men remaining permanently at the works for the above purpose."

It will be seen from the above that the specifications contemplate an inspection service at the works, dealing with the manufacture from the raw materials to the shipping of the product, and just such a service is actually in force. The specifications of the Ponts et Chaussées have been adopted by the Military Engigineers, and by the Colonial Administration, and the city of Paris has adopted quite similar requirements. In this way we find in French cement works a number of inspectors present, one representing, say the maritime service of the Ponts et Chaussées, another the inland service for the same corps, another representing the city of Paris, and perhaps a fourth representing the military organization. The case is exactly the same as in an American steel works, where numerous inspectors are present representing purchasers. Thus the French works are brought into direct contact with the engineer corps, with the schools and with the best science.

The Works of Darsy, Lefebvre, Stenne and Lavocat at Neufchatel.

These works were established in 1862 by Messrs. Darsy & Lefebvre and are now under the direction of Mr. Lavocat, through whose courtesy the writer was permitted to see the plant. It is located at Neufchâtel, a quarter of an hour's ride by rail to the south of Boulogne, and is quite a large plant, having 15 Johnson kilns and six continuous kilns. The raw materials are marl and clay. The marl comes from a quarry two-thirds of a mile away and the clay from the valley beyond. The marl as quarried contains considerable clay, varying from 10 per cent. up to the full amount required for cement slurry (say 22 per cent.), and hence the amount of clay which it is necessary to add is small.

The thing which impresses one first in visiting a French ce-

ment plant is the extreme simplicity of the arrangements and the careful study of economy in manual labor. The conditions in France approach more nearly to our own in that respect than elsewhere in Europe. Labor is dear, and so we find Mr. Lavocat bringing his marl to the wash mills by rail in dump cars, using an electric trolley locomotive just as in the latest practice in America. One locomotive and a small crew thus does all the hauling of the marl. We also find that the analysis of the raw materials figure very little in French manufacturing. The clay and marl are mixed in the wash mills in proportions which are merely approximate. It is the bassins de dosage and not the wash mills which determine the proportions of the slurry. Mr. Lavocat has three wash mills, two of which are in use; from them the slurry overflows through fine metal sieves and runs with a gentle slope into one of the three bassins de dosage. On the other side of these bassins doseurs are two small wash mills, one using a marl of known composition and the other using pure clay. It is not until a bassin de dosage is full of slurry that the French chemist appears upon the scene. He then takes samples of the slurry and analyzes it, not for carbonic acid by volumetric determination, as is common in Germany, but for clay by gravimetric methods. At the Darsy works the limiting figures for clay are from 21 to 22 per cent., and any variation beyond these figures is corrected by adding pure clay or pure marl to the basin from the small wash mills described above. It may take one, two or three determinations to get the right mixture, but it is not until the mixture is normal that the slurry escapes from the bassins de dosage and it is not until it is considered normal that the inspectors of the Ponts et Chaussées take their samples.

The laboratory of the Maritime Service of the Ponts et Chaussées is at Boulogne and is under the direction of Mr. Feret, the well-known engineer. Mr. Lavocat showed the writer a long series of check analyses made there on the slurry which the inspectors had sampled. The results and analyses made under the direction of Mr. Feret are available to the manufacturers of the cement, and it is apparent that while the supervision of the Ponts et Chausées is close and rigid, the relations which it sustains to manufacturers are nevertheless cordial, the results obtained being always freely available to a manufacturer for his information and guidance.

From the bassins de dosage the slurry runs by gravity to the drying chambers of the Johnson kilns. These kilns are exactly like those described in England, that is, they are discontinuous kilns, having long drying chambers between the kilns and the chimney in which the slurry is dried by the products of combustion.

The kilns, which are really French and new to this correspondence, are the continuous kilns mentioned above. For the service of these kilns the slurry is run into settling basins, like those in Germany, where half the water is gotten rid of by evaporation and decantation. The balance of the water is eliminated in the drying chambers of the kilns, being brought there in cars by elevator. The lower drying chambers are laid with rails and there are turn-tables and switches, so that the cars reach all parts of the upper and lower drying chambers of these kilns. Now it will be apparent to your readers that a continuous kiln with drying chambers is a novelty. Nothing of the kind has been mentioned before in this correspondence, and this kiln is, in fact, an evolution of French practice. Imagine, then, a kiln of the Johnson type, made higher and narrower and having two sets of chambers (upper and lower for each), instead of one leading from the kiln to the chimney. It is evident, then, that by valves or ports the products of combustion can then be made to pass at will either through one pair of chambers or the other, and the operation of the kiln can thus proceed continuously, regardless of the charging and discharging of the material from the drying chambers. The scheme is very simple, and the furnace itself is extremely simple in design. The slurry and the coal are charged into the kiln from the top through an opening arranged like the charging door of a blast furnace. At the Darsy works there is also a door in the side opposite to the drying chambers, through which the fire can be observed and clinker and coal added if desirable. These kilns produce about twice the product per day that can be obtained from a discontinuous Johnson kiln, and achieve considerable economy in fuel besides. The cost of manual labor is said to be about the same. The six continuous kilns at these works as originally built were Johnson kilns and were remodeled by Mr. Lavocat into their present shape.

On the clinker floor at the bottom of the kilns the writer

gets a view of what the Ponts et Chaussées requires in the way of sorting clinker. Heaped against the walls opposite certain furnaces are piles of clean hard black clinker, quite free from underburnt or dirt. It is the very choice and pick of the product. Mr. Lavocat explains that this is for the sea water work, and is required by the inspectors of the Maritime Service, and he admits, too, that it is quite right for sea water work that all the underburnt clinker should be excluded. Referring to the specifications for the Maritime Service we find that the cement is "required to be produced by the grinding of scorified clinker obtained by calcining to the softening point of an intimate mixture of carbonate of lime and clay, rigorously proportioned chemically and physically homogeneous in all its parts." The specifications further require that cements containing more than 1 per cent. of sulphuric acid or sulphides in determinable proportions will be refused and that any cement will be declared suspected that has more than 4 per cent. of oxide of iron, or which will give a less value than 44 per cent. for the ratio of combined silica plus alumina to the lime. This demand of the French specifications for pure cement with a selection of the very best clinker may account for the remarkable success which the French engineers have achieved in their maritime works.

The grinding of clinker at the Darsy works is entirely by millstones, and the fineness is determined by bolting the ground powder. The entire works are very ingeniously arranged with many clever devices which show Mr. Lavocat to be an accomplished engineer.

Works of E. Candlot et Cie., at Dennemont.

These works are new, having been built in 1893. They also develop a new cement industry, no works having been previously built in this vicinity. The conception of the enterprise is due to Mr. Edouard Candlot, the well-known French engineer and author, who had previously been for years the director of the works at Boulogne of the Société Anonyme des Ciments Français, the company which owns the largest cement plant in France.

This new enterprise is on the left bank of the Seine and about an hour's ride by express train from Paris by the Western Railroad. The works at Dennemont are quite unique in plan. They are interesting not only as being the newest works in France,

but because they represent the ideas of Mr. Candlot in developing a plant to suit local conditions. The property is situated on the Seine, and the river is the source of supply for fuel and the shipping outlet of the works. From the river there is a plateau of about 1,000 feet to the foot of the hill, and it is here at the base of the hill that the works have been built. At first sight this appears awkward, but after examining the plant it is found to provide a convenient and economical plan for construction, and to be quite economical in manual labor in operation. The raw material (chalk) is quarried in tunnels running directly into the hillside opposite to and a little above the level of the wash mills. Thus the cars run by gravity to the wash mills and the slurry runs by gravity to the bassins de dosage; thence is pumped directly through a height of 100 feet to the settling basins on the top of the bluff. This is the only operation in which gravity is adverse and it is cheaply performed by power. The settling basins are high enough above the kilns to permit thick slurry to run into the drying chambers. In burning, the clinker passes from the top of the kilns to the bottom, and the outlet at the bottom is at a little elevation above the crushing machinery. Still a little lower down is the upper floor of the mill building, and still below the mill building is the storehouse for the ground cement. Thus, after the slurry is pumped to the top of the hill, the course of the material is regularly downward, with gravity to assist each operation.

The coal, of course, has to be carried to the top of the kilns, as in all other works. This is done by a cableway leading from the river to the top of the hillside. At the river side for handling the coal and for loading the cement is an electric locomotive jib crane. The whole scheme is ingeniously worked out, and the product of the works is evidently unusually large for the manual labor employed. The kilns at the Dennemont plant are continuous kilns of the same type described above for the Darsy plant, a little more modern and a little simpler in design, but essentially the same; and the process of handling the materials and determining the dosage is exactly the same, and hence need not be further described.

Mr. Candlot is a firm believer in what the French call "ciment armé;" that is, cement work built on an iron skeleton of wire, expanded metal or other device of this kind. The floors of the

buildings are sustained by beams and flooring of this "ciment armé" and the hoppers bringing the clinker to the mills are also built of it. Also the hoods in the laboratory and even the slabs which cover the lower drying chambers of the kilns are made of it. All of it is in excellent condition, though the mills are doing service under very heavy loads.

At the Dennemont works there are usually three inspectors representing the Ponts et Chaussées and the city of Paris. The output of the works is about 120,000 barrels per annum and is largely consumed by the city of Paris, which is its natural market.

As showing the quality of the French Portland cements, the following reports will be of interest:

Portland cement made by Messrs. Darsy, Lefebvre & Lavocat. Tests by Feret at Boulogne.

Setting Time.—Initial set, 3 degrees, 20 minutes; final set, 9 degrees.

Fineness.—Two per cent. residue on sieve of 5,850 meshes per square inch; 22 per cent. residue on sieve of 32,500 meshes per square inch.

Tensile Tests.—Seven day neat, 550 pounds; 28 day neat, 730 pounds; 7 day, 1 to 3 sand, 270 pounds; 28 day, 1 to 3 sand, 385 pounds.

Chemical Analysis.—Silica, 22.15 per cent.; alumina, 8.20 per cent.; oxide of iron, 2.50 per cent.; lime, 63.60 per cent.; magnesia, 0.85 per cent.; sulphuric acid, 1.20 per cent.; loss in calcination and undetermined, 1.50 per cent.

Portland cement made by Messrs. E. Candlot & Cie.

Setting Time.—Initial set, 1 degree 40 minutes; final set, 3 degrees 0 minute.

Tensile Strength.

	2 days.	7 days.	28 days.	84 days.	6 mons.
Neat cement	384 lbs.	669 lbs.	752 lbs.	757 lbs.	707 lbs.
1 cement to 2 sand	296 "	498 "	553 "	589 "	610 "
1 cement to 3 sand	232 "	373 "	437 "	447 "	481 "
1 cement to 5 sand	112 "	202 "	236 "	267 "	301 "

Chemical Analysis.—Silica, 21.70 per cent.; alumina, 8.00 per cent.; peroxide of iron, 2.60 per cent.; lime, 63.85 per cent.; magnesia, 0.72 per cent.; sulphuric acid, 0.60 per cent.; loss in calcination, 2.30 per cent.; elements undetermined, 0.23 per cent.

THE

American Cement Industry.

After the publication in THE ENGINEERING RECORD of the articles on the European Portland Cement Industry, which are reprinted in the preceding pages, many requests were received for descriptions of the cement industry in the United States. Accordingly, Mr. Frederick H. Lewis, M. Am. Soc. C. E., was requested to begin the preparation of such a series of papers, and up to the close of 1898 had furnished the following :

Dec 18, 1897.—Coplay Plant, at Coplay, Pa.
Jan 15, 1898 —Lawrence Cement Co. (Binnewater Plant)
Feb. 5, 1898.—New York & Rosendale Cement Co. (Rosendale Plant)
April 2, 1898.—Milwaukee Cement Co. (Plant No. 2).
April 30, 1898.—Bronson Portland Cement Co. (Bronson, Mich.)
May 21, 1898 —Candlot Oscillating Grate for Cement Kilns.
July 16, 1898.—Empire Portland Cement Co. (Warners, N. Y.).
Sept 10, 1898.—Natural Cement Plant, at Speeds, Ind.
Oct. 15, 1898 —Buckeye Portland Cement Co. (Bellefontaine, O.).
Nov. 19, 1898.—Western Portland Cement Co. (Yankton, S. D.).
Dec. 17, 1898.—The American Rotary Kiln Process for Portland Cement.

The editions of some of these numbers are exhausted, and parties wanting a full set of papers must make a special arrangement for them.

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